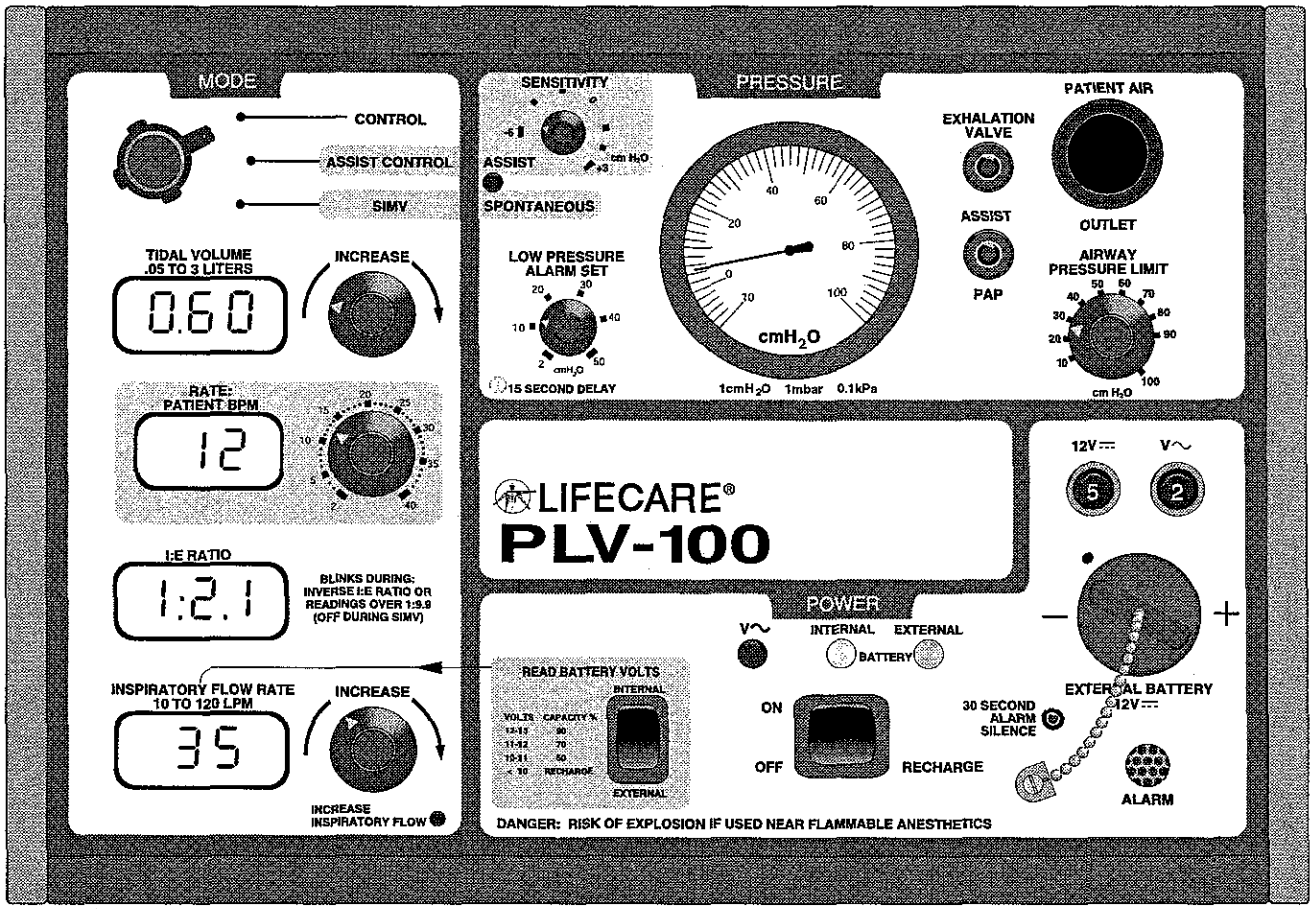
RESPIRONICS®

Service Manual PLV-100



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Reorder # 1004890

Revision # 1013706

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Introduction

Section 1.0

About this Manual
Servicing and Warranty
Service Location
Service and Inspection Forms
Recommended Service, Repair, and Test Equipment
Engineering Change Orders
Equipment Inspection
Authorized Service Centers
Servicing Guidelines

About this Manual

▼This manual is intended for use when servicing the Respironics® PLV-100. Included in this manual are sections covering troubleshooting, circuit descriptions, and testing. Personnel servicing the PLV-100 should be thoroughly familiar with the PLV-100 Operating Manual and the ventilator's functions. The information contained within this document is subject to change without notice.

This procedure is written for a technician experienced in volt meter usage, soldering, and electrical troubleshooting. **Do not attempt to repair the PLV-100** otherwise. Unauthorized repair voids the warranty. Refer to the PLV-100 Operating Manual for complete warranty information.

A **WARNING** notifies when there is a possible hazard or danger to the Patient or Service Personnel.

A **Caution** notifies when possible damage may occur to the device.

Servicing and Warranty

▼Respironics recommends that the PLV-100 be serviced by Respironics or an authorized Service Center once per year or every 8,000 hours as recorded by the hour meter, whichever comes first. This allows Respironics Service Personnel to check the performance of the unit, check the electrical integrity, and replace parts as necessary.

Respironics warrants the PLV-100 to be free from defects in material and workmanship for a period of one year after delivery, provided that the unit is properly operated under normal conditions. Respironics makes replacements, repairs, or issues credit for equipment or parts which are found to be defective. The defective unit may be returned prepaid to Respironics after the customer has received approval to return the unit.

This warranty does not apply to any unit or individual parts which have been repaired or altered in a way that, in Respironics' judgement, affect its stability or reliability, or which has been subjected to misuse, negligence, abuse, or accident.

This warranty does not cover damage which may occur in shipment. If there is any damage during shipping, please contact the carrier or individual who delivered the unit.

Respironics offers a month-to-month maintenance contract on the PLV-100. The maintenance contract covers all parts, labor, and loaner ventilators. If a unit is out of warranty, and a maintenance contract is desired, it is necessary for the owner to submit the unit to Respironics or a Respironics

Servicing and Warranty
Continued

distributor for servicing, on a time and material basis, to bring the unit in-line with Respironics standards. The unit can then be placed under a month-to-month maintenance contract.

Respironics®, Inc. has a policy of continued product improvement and reserve the right to alter specifications without notice.

Service Location

▼The PLV-100 may be repaired at Respironics Service Centers located throughout most of the world. Please call 800-345-6443 or 724-387-4000 for the location of the Respironics Service Center nearest you.

WARNING: Federal law restricts this device to sale by or on the order of a physician.

Service and Inspection Forms

▼During servicing or inspection of the PLV-100 the following forms and procedures are used:

PLV-100 QA Final Inspection Form
QA Final Inspection for PLV-100
PLV-100 Operating Manual

Copies of these forms can be found in Section 14.0 QA Final Inspection Forms and Procedures.

Recommended Service, Repair, and Test Equipment

Respironics Part Number	Description
98555	Torque Driver
98557	Socket, 1/4" Drive x 5/16"
98260	Tie Wrap Gun
90902	Gate Valve Assembly
98573	Magnehelic Gauge, 0-20 cm H_2O
98574	Magnehelic Gauge, 0-150 cm H_2O
90032	Faceplate Bushing Press Tool
90037	Pressure Restrictor, PLV
98559	Allen Driver Set
98560	Nut Driver Set
98251	Soldering Station
98577	Fluke Meter/Ohmmeter (Multimeter)
98144	Solder Wick, 110" Copper
98128	Wrist Strap, Antistatic
98129	Wrist Cord, Antistatic
98906	Cord, Wrist Strap, Grounding
98537	Mat, Table, Antistatic, 2' x 4'
98561	Pliers, Snap Ring
98565	Heat Gun
98576	Safety Inspector, SI-100 Tester
98607	Socket Adapter, 1/4", Torque Driver
C06120	PLV Hose Assembly
C06335	Connector, Silicone
C06348	Coupler, 22 mm I.D. Silicone
C06658	Test Lung, 1 liter
C06712	PEEP Valve

Miscellaneous Equipment

0-12 Volt Adjustable DC Power Supply
Wire Cutters
Needle Nose Pliers
Regular Pliers
Straight Blade Screwdriver
Jewelers Screwdriver Set
Phillips Head Screwdriver
Wire Strippers
External Retaining Ring Tool
Solder, Pure, 60/40
Jumper Wire with 1K ohm Resister
* Calibrated Respironics® Pressure Alarm
* Timeter RT-200A
* Digital Pressure Manometer

* May be used in place of the Magnehelic Gauge

Engineering Change Orders

▼Any ECO not installed in a unit, must be installed during service of the PLV-100, unless it is listed as optional in this service manual. Procedures for incorporating ECOs are found in Section 8.0 of this manual.

Equipment Inspection

▼Standard operating procedure requires Respironics Distributors and authorized Service Centers to perform a Final QA Inspection of the PLV-100 after servicing a unit.

It is mandatory that all Respironics service personnel follow the QA Final Inspection for the PLV-100 before the unit is released to a client. These inspection guidelines provide a step-by-step procedure for documenting the results of tests performed on the operation of a PLV-100.

Final QA inspection performed on a PLV-100 includes such criteria as internal and external inspection, diagnostic check, airway pressure, flow and rate check, and shipping configurations. The results, date and inspector's signature are recorded on each inspection form.

Any PLV-100 rejected during finished device inspection, and later reworked or remanufactured, is subject to another complete final inspection.

Authorized Service Centers

▼Only those individuals/facilities which attend authorized Respironics Service Training Schools are sold replacement parts. For information on training contact the Technical Services Department at 800-345-6443 or 724-387-4000.

Servicing Guidelines

▼Perform the decontamination procedure for returned equipment upon initial receipt of a ventilator from the client or hospital. The decontamination procedure must be completed before beginning service or handling the unit.

If the number of Hours Remaining since the last Preventive Service is GREATER than 6,500 hours, and the unit **is not** being serviced due to a complaint, perform Operational Checks (Section 5.0). If the unit fails Operational Checks, perform the steps in Sections 6.0 through 10.0.

Note: DO NOT change or replace the Preventive Service Due label behind the filter housing if a Preventive Service is not performed. The number of hours recorded on this label must be maintained for any future service required.

If the number of Hours Remaining is LESS than 6,500 hours, and the unit **is not** being serviced due to a complaint, perform Operational Checks. If unit passes Operational Checks, perform Preventive Service (Section 6.0) and Calibration (Section 10.0).

Servicing Guidelines
Continued

If the unit fails Operational Checks, perform the steps in Sections 6.0 through 10.0.

> **NOTE:** A unit passes Operational Checks if no discrepancy is discovered in unit operation other than volume adjustment, dump valve adjustment, internal battery replacement, pressure relief valve adjustment, gauge replacement, power board voltage adjustments, or other minor repairs or adjustments that do not require disassembly of the unit other than the top and bottom panels of the unit.

If the unit is being serviced due to a complaint, perform Operational Checks to find any other discrepancies with unit operation. The steps in Sections 6.0 through 10.0, including Preventive Service MUST also be performed, regardless of the number of Hours Remaining.

A unit automatically fails operational checks if any mandatory ECO is not installed.

Refer to the flow chart on the next page for a further description of servicing guidelines.

Servicing Guidelines
Continued

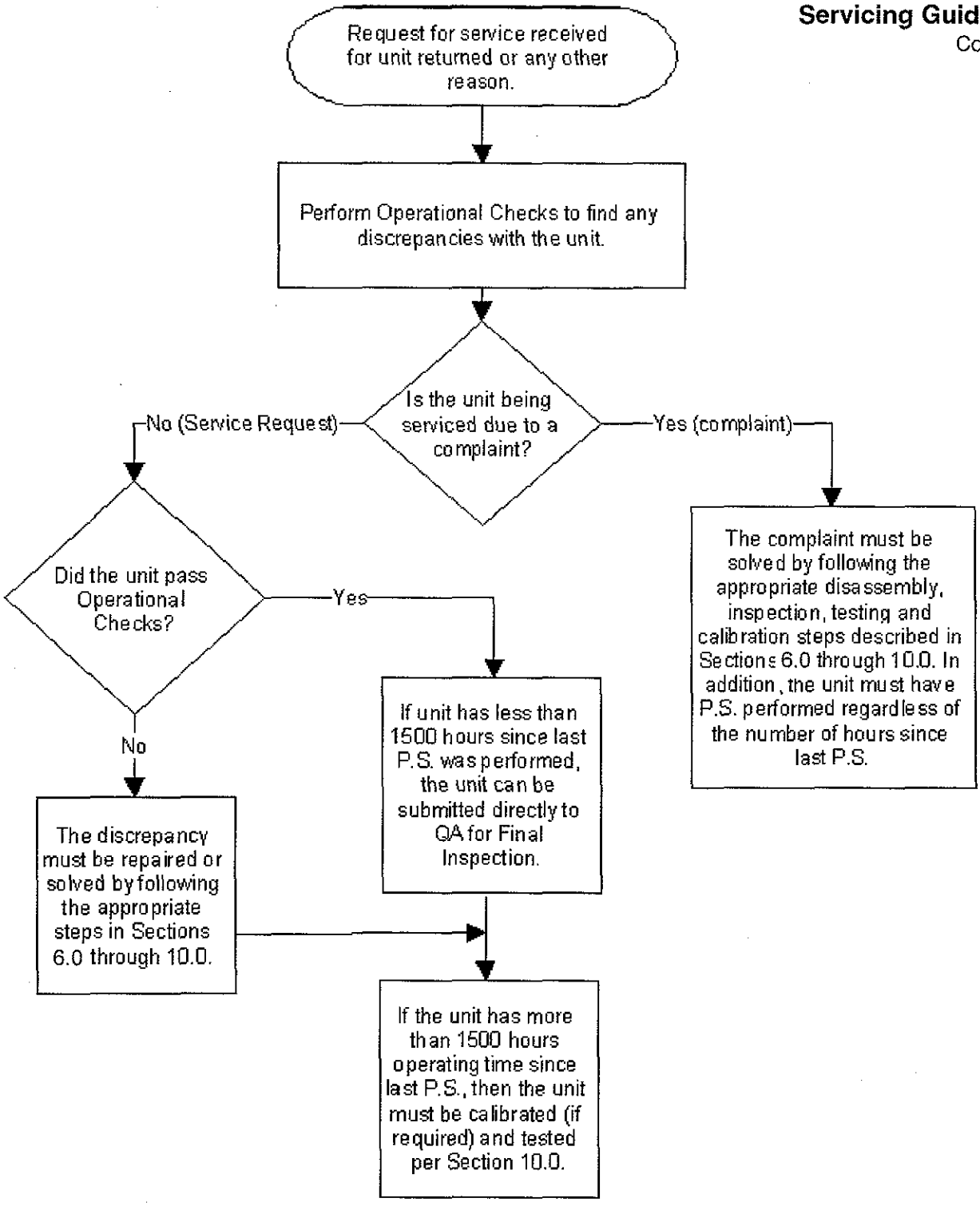
Request for service received for unit returned or any other reason.
Perform Operational Checks to find any discrepancies with the unit.
Is the unit being serviced due to a complaint?
No (Service Request)
Yes (complaint)
The complaint must be solved by following the appropriate disassembly, inspection, testing and calibration steps described in Sections 6.0 through 10.0. In addition, the unit must have P.S. performed regardless of the number of hours since last P.S.
Did the unit pass Operational Checks?
Yes
No
If unit has less than 1500 hours since last P.S. was performed, the unit can be submitted directly to QA for Final Inspection.
The discrepancy must be repaired or solved by following the appropriate steps in Sections 6.0 through 10.0.
If the unit has more than 1500 hours operating time since last P.S., then the unit must be calibrated (if required) and tested per Section 10.0.

Figure 1-1: *Servicing Guidelines*

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Warnings and Cautions

Section 2.0

Warnings and Cautions
ESDS Warnings and Cautions

Warnings and Cautions

- The PLV-100 must be periodically checked and maintained to ensure proper operation.
- Connect the PLV-100 to a grounded hospital grade outlet only.
- PLV-100 performance may be affected at temperatures below -5°C (23°F) and above 41°C (106°F).
- DO NOT use the PLV-100 to charge a deeply discharged external battery. An external, 10-amp battery charger is recommended.
- Connect the external 12 VDC battery cable as follows:

  a. WHITE wire to POSITIVE (+) battery terminal.
  b. BLACK wire to NEGATIVE (-) battery terminal.

- PLV-100 performance may be affected when the internal batteries reach a "low voltage" alarm condition.
- DO NOT disconnect an external battery while the unit is operating under load. This may cause the unit to repeat the diagnostic start-up cycle.
- DO NOT use the internal batteries in place of external batteries. The internal batteries are for emergency use only.
- DO NOT use the PLV-100 in the presence of flammable anesthetics.
- Oxygen can be bled into the PLV-100 by using an O_2 accumulator. DO NOT use oil or grease in or near oxygen equipment or near the PLV-100 ventilator.
- DO NOT operate the PLV-100 from the same battery that powers an electric wheelchair. Doing this may reduce the operating time of the PLV-100 from the 12 VDC external power source.
- Replace the back panel shipping fuse, if needed, with a 5-amp slow blow fuse, type 3AG.
- The PLV-100 power transformer is rated between 105 and 130 VAC, 60 Hz, sine wave input. Due to the wide variety of wave forms and voltage produced by inverters, it is recommended that the PLV-100 operate only on a 12 VDC power supply when used in mobile vehicles such as ambulances and aircraft.
- The internal batteries may be damaged if the PLV-100 is stored for long periods of time without recharge. For proper internal battery maintenance, the unit must be connected to an appropriate VAC power source for 24 hours at least every three weeks.
- Verify that the alarms are set correctly and are operational.

ESDS Warnings and Cautions

- All ESDS items must be stored in approved conductive packaging, tubes, shipping bags, foam or tote bins.
- All persons handling ESDS items must be grounded via a 1 Meg ohm resistive grounded wrist strap.
- Cover all ESDS bench tops with grounded conductive mats and connect all work surfaces and equipment to earth ground.
- Transport all assemblies containing ESDS items in a conductive bag or container.
- DO NOT use cellophane adhesive tape to wrap DIP (dual in-line package) tubes together.
- DO NOT handle ESDS items by their pins or mix them with other routine electronic parts.
- Never place ESDS items on ungrounded surfaces or leave them unattended in an open area.
- Avoid cellophane wrappers, synthetic carpeting, warm or cool air blasts, styrofoam coffee cups, etc. when working with ESDS items.
- Use only ESD safe solder suckers, grounded soldering irons, and grounded DIP installation tools.
- Use only properly designed heat lamps, heat chambers and/or "antistatic" quick-chill sprays during troubleshooting or stress testing procedures.
- The following assemblies in the PLV-100 are easily damaged by ESD and require special handling:

  Digital Board (Front Panel Assembly)
  Zero Board (Bulkhead Assembly)
  Power Board (Right Module)
  Amp Board (Back Panel)

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Specifications and Alarms

Section 3.0

Front Panel Controls
Front Panel Visual Indicators
Temperature Specifications
Physical
Operation Time on Batteries
Battery Charging
Alarm or Alert Indicators
Power Sources
Connections for 220 or 240 VAC Operation

Front Panel Controls

- **Mode Selection**
  CONTROL, ASSIST/CONTROL, SIMV
- **Tidal Volume**
  0.05 - 0.20 ± 0.02 liters; 0.20 - 3.00 liters ± 10%
- **Breath Rate**
  2 to 36 ± 0.5 BPM; 36 to 40 ± 2 BPM
- **Inspiratory Flow Rate***
  10 to 120 liters per minute
- **Battery Test Switch**
  Internal, External Battery
- **Main Power Switch**
  On, Off/Recharge
- **DC Circuit Breaker**
  Push-Pull Actuation
- **AC Circuit Breaker**
  Push-Pull Actuation
- **Airway Pressure Limit**
  5 to 100 ± 5 cm H_2O
- **Sensitivity**
  +3 to at least -6 cm ± 1 H_2O
- **Low Pressure Alarm**
  2 to 40 ± 2 cm H_2O
- **Alarm Silence Button**
  30 seconds, Automatic Reset

* Peak flow rate during inspiratory time.

Front Panel Visual Indicators

- **Tidal Volume**
  Digital Display
- **Rate: Patient Breaths Per Minute**
  Digital Display
- **I:E Ratio**
  Digital Display
- **Inspiratory Flow Rate**
  Digital Display

Front Panel Visual Indicators
Continued

- **Increase Inspiratory Flow****
  Red Indicator Light
- **120 (220/240) VAC Power**
  Green Indicator Light
- **Internal Battery Source**
  Amber Indicator Light
- **External Battery Source**
  Yellow Indicator Light
- **Patient Airway Pressure**
  -10 to 100 cm H_2O
- **Assist/Spontaneous**
  Green Indicator Light
- **15 Second Delay (Low Pressure Alarm)**
  Green Indicator Light

** Flow waveform sinusoidal drive on all breaths.

Temperature Specifications

- **Operating Temperature Range**
  -5° to + 41°C
  (+23°F to +106°F)

Physical

- **Dimensions**
  22.9 cm X 31.1 cm x 31.1 cm
- **Weight**
  12.8 Kg (28.2 lb)

Operation Time on Batteries

- **12 VDC External Battery**
  Approximately 24 hrs.
- **12 VDC Internal Battery**
  Approximately 1 hr.

Operation time is lessened if conditions causing increased power consumption exist such as extreme settings.

Battery Charging

- **PLV-100**
  Trickle charge to internal and external batteries
- **Optional External Chargers**
  2 amp charger, 10 amp charger

Alarm or Alert Indicators

- **Low Pressure**
  Visual/Continuous Audible
- **High Pressure**
  Intermittent Audible
- **Apnea**
  Visual/Continuous Audible
- **Inverse I:E Ratio**
  Visual Warning
- **Increase Inspiratory Flow**
  Visual Warning
- **Low Internal Battery**
  Visual/Continuous Audible
- **Low External Battery**
  Visual/Continuous Audible
- **Reverse Battery Connection**
  Continuous Audible
- **Power Failure**
  Continuous Audible
- **Unit Malfunction**
  Intermittent Audible
- **Power Source Change**
  Audible
- **Alarm Silence**
  Continuous Visual while activated

Power Sources

- **120 VAC 50/60 HZ**
  US, Canada Models
- **220/240 VAC 50/60 Hz or 100 VAC 50/60 Hz**
  International Models
- **12 VDC External Battery**
  105 amp hrs Marine Deep cycle recommended
- **12 VDC Sources**
  Automobile or boat battery by direct connection or using Respironics Auto Lighter Cable
- **12 VDC Internal Battery**
  Sealed lead acid gel, 2.5 amp hrs.

NOTE: Throughout the entire Service Manual, "120 VAC 50/60 Hz" shall also imply "220/240 VAC 50/60 Hz or 100 VAC 50/60 Hz" on International models.

Connections for 220 or 240 VAC Operation

- International model versions of the PLV-100 may be wired to accept 220 or 240 VAC input current. Both operate between 50 and 60 Hz, (see figure 3-1).
- **220 VAC Operation:**

  Connect the brown lead from the toroid transformer to the white AC lead from the back panel module. The two black wires connect as shown.
- **240 VAC Operation:**

  Connect the white lead from the toroid to the white AC lead from the back panel module. The black wires connect as shown.

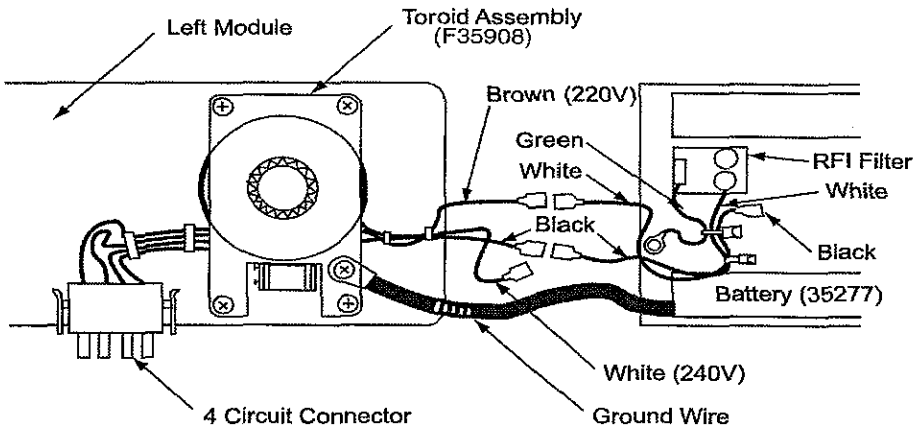

Figure 3-1: *100 Module Connection 220/240 VAC*

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Troubleshooting Chart

Section 4.0

Troubleshooting Chart
System Start-Up Problems
Failure Alarms and LED Indications
Piston Operation Problems
Dump Valve Problems

Troubleshooting Chart

▼The possible causes and actions/solutions listed below are used as guidelines for troubleshooting the PLV-100. This list is **NOT** complete and other possible causes and solutions should **NOT** be ruled out. Refer to Theory of Operation and PCB schematics, as needed, to further troubleshoot the PLV-100.

If there is a problem with a certain part of a circuit, check continuity of all traces, and inspect for fractured solder joints.

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
SYSTEM START-UP PROBLEMS		
1.0 No AC or DC operation.	1.1 Defective power switch.	1.1 Check voltage across **closed** power switch. If voltage is measured, replace power switch.
	1.2 Broken wires at power switch.	1.2 Inspect wires at power switch. Replace wires if broken.
	1.3 Solder joint at switch terminal.	1.3 Inspect solder joints at power switch. Resolder connections if poor wetting.
	1.4 Defective DC circuit breaker.	1.4 Check voltage across **closed** DC circuit breaker. Replace DC circuit breaker if a voltage of ~14 VDC is measured.
	1.5 Q10 is defective, (power board 35903).	1.5 Check voltage at TP7, replace Q10 Pin 2 if no voltage is measured .
	1.6 Q9 is defective, (35903). U2 is defective, (power board 35950).	1.6 Check voltage at TP8. Replace Q9 or U2 if no voltage is measured.
	1.7 No continuity or poor in-line connections.	1.7 Check connections at path of incoming raw power. Repair if connection is poor.
2.0 No AC operation, but unit operates on DC.	2.1 Damaged line cord.	2.1 Inspect line cord for damage. Replace cord if damaged.
	2.2 Defective AC circuit breaker.	2.2 Check voltage across **closed** AC circuit breaker. Replace AC circuit breaker if raw voltage is measured.
	2.3 Toroid defective.	2.3 Check Toroid output for 17.8 VAC across RV2.
	2.4 No power at wall outlet.	2.4 Plug unit into a different outlet.
	2.5 Microfuse on power board blown.	2.5 Inspect fuse. Replace if blown

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
2.0 (Continued)	2.6 Q3 is defective, (F35950).	2.6 Check raw voltage. Check output at Q3, Pin 3. Also check U11.
3.0 No DC operation, (but unit operates of AC)	3.1 Back panel fuse open.	3.1 Inspect back panel fuse. Replace fuse if open. Check for possible shorts in unit if fuse continues to blow.
	3.2 Internal battery not charged, or does not hold a charge.	3.2 Perform battery charging test for 24 hours. After charging the battery check for 14.2 V at TP1. Discard the battery if not.
	3.3 External battery not charged, or does not hold a charge.	3.3 Replace the external battery.
	3.4 CR11 or K1 have failed on power board 35950. K1 or Q7 on power board 35903.	3.4 Check the voltage at TP1, 4, 5. Replace CR11 or K1 if voltage is present at TP1 or 4, but not TP5. Or K1 or Q7.
	3.5 Q7 is defective, (35903).	3.5 Check if Q7 or K1 is open. Replace if defective.
4.0 Unit switches from AC to DC intermittently	4.1 Defective power cord.	4.1 Measure voltage across the power cord. Replace the cord if the power fluctuates.
	4.2 Circuit breaker may or may not trip.	4.2 Reset circuit breaker.
	4.3 Toroid or RFI is disconnected or has a bad connection.	4.3 Perform continuity checks on Toroid or RFI circuit. Replace or repair as necessary.
5.0 Unit continuously runs through diagnostics when plugged into both AC power and connected to the external battery, but runs normally when connected only to AC power or only to the external battery	5.1 U19 is defective.	5.1 Check inputs and outputs on U19. Replace U19 if not in accordance.
	5.2 CR11 is defective.	5.2 Check CR11 on power board. Replace if defective.
6.0 Unit goes through diagnostic, but does not start cycling	6.1 Amp board cable is disconnected.	6.1 Check amp board cable for disconnection.
	6.2 Oscillator is out of frequency, (F35950).	6.2 Check TP7 for low voltage. Check analog circuit.

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
6.0 (Continued)	6.3 Oscillator is out of frequency, (35903).	6.3 Check TP8 for low voltage. Check analog circuit.
	6.4 Clock oscillator has a bad signal.	6.4 Using positive lead of voltmeter or oscilloscope probe Pin 8 of the clock oscillator to check for proper signal.
7.0 Unit fails to cycle when turned on, and manometer has 2 cmH_2O or greater applied	7.1 Disconnected or bad solenoid. Volume window displays 1.0.	7.1 Check solenoid. Replace if necessary.
	7.2 Open wire on harness. Defective transducer, amp board, associated plumbing or circuitry. Volume window displays 1.0.	7.2 Repair as needed
	7.3 Bad op amp (U3).	7.3 If PX1 or PX10 are both equal, (low voltage), with 40 cm of pressure applied, replace op amp.
FAILURE ALARMS AND LED INDICATIONS		
8.0 Power source LED does not switch from internal to VAC when connected to an AC power source.	8.1 Defective multiplexer.	8.1 Check U19 on logic board, for a reading of ~4V. Replace as necessary.
	8.2 No continuity on 50-pin ribbon cable.	8.2 Check ribbon cable for continuity. Replace cable if the is no continuity.
	8.3 Various possible causes.	8.3 Check for AC at AC circuit breaker or low AC. Check A to D converter using U27 on the logic board. Check TP3 for unregulated or raw voltage. Check Pin 3 on power board for a reading of ~20 V. Check RP3 Pin 16 on the logic board for a reading of ~20 V.
9.0 Display LCD segments never turns on or never turns off.	9.1 Dirty or bad LCD socket contacts.	9.1 Check LCD socket contacts. Replace LCD socket or driver chip if bad or dirty.

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
10.0 Audible alarm sounds constantly.	10.1 Unit does not reach set pressure.	10.1 Check for internal or external tubing leaks. Replace tubing as necessary.
	10.2 Logic board switch 1B shorted.	10.2 Repair short as necessary. Switch in off position is isolated. Replace components associated with a short as necessary.
	10.3 Q1, 2, or 16 is defective, (35903).	10.3 Remove alarm battery and check for a voltage of 3.6V.
	10.4 Q7 or 8 is defective, (F35950).	10.4 Remove alarm battery and check for a voltage of 3.6V.
	10.5 CR23 is defective, (35903).	10.5 Check if CR23 is open. Replace if defective.
	10.6 TO-3 socket shorting out Q13.	10.6 Inspect Q13, replace as necessary.
	10.7 Q1 is shorted from emitter to base, (35903).	10.7 Check Q1. Replace if shorted.
11.0 Audible alarm never sounds.	11.1 Alarm battery is defective, (35903).	11.1 Check the voltage at TP6 for a minimum reading of 3.6V. Replace U14 if reading is less. Check the voltage at TP7.
	11.2 Q8 and Q10 are defective, (F35950).	11.2 Check the voltage at TP8. Replace Q8 and Q10 as necessary.
	11.3 Power switch is open.	11.3 Check the power switch and replace if open.
	11.4 Bad alarm connections or faulty alarm transducer.	11.4 Check the alarm module and wiring. Replace as necessary.
12.0 Audible alarm sounds constantly when unit is plugged into AC power source and turned off.	12.1 Power switch has failed.	12.1 Check for continuity and isolation between switching.
	12.2 Q1 is defective, (F35950).	12.2 Check Q1, replace if defective.
	12.3 Q4 is defective, (35903).	12.3 Check Q4, replace if defective.
	12.4 Digital board or power board is contaminated.	12.4 Clean board.

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
12.0 (Continued).	12.5 Alarm battery is low.	12.5 Replace if battery fails alarm battery charging test.
	12.6 Pressure switch has failed. Volume window displays 1.0.	12.6 Replace pressure switch.
	12.7 U8 is defective.	12.7 Check gain at Pin 1. Check output of U4, Pin 1. Voltage is between 0.78 and 0.92 at null.
	12.8 50-pin cable is defective.	12.8 Check cable. Replace if defective.
13.0 External power source LED is flashing.	13.1 External power source is low.	13.1 Charge or replace external power.
	13.2 Q7 dual schottky is leaking, (35903).	13.2 Measure external battery connector. It must read less than 1.5V. Replace Q7 if leaking.
	13.3 CR11 is leaking, (F35950).	13.3 Measure external battery connector. Replace CR11 if leaking.
14.0 Audible alarm sounds and then slowly fades.	14.1 Trace shows continuity.	14.1 Measure infinite resistance on the trace cut when alarm charger board was installed. Recut trace if resistance reading is not infinite.
	14.2 Defective alarm charger board, (35903).	14.2 Check alarm charger board. Replace as necessary.
	14.3 Defective alarm charger PCB, (35903).	14.3 Replace PCB. A functional board causes voltages at the alarm battery to increase once the alarm starts sounding.
	14.4 Defective alarm or alarm battery, (35903).	14.4 Check alarm and alarm battery. Replace as necessary.
15.0 Alarm volume not loud enough.	15.1 Low power source.	15.1 Check supply voltage. Charge or replace as necessary.
16.0 Unit stalls and gives intermittent alarm. Unit may or may not restart.	16.1 Ball screw lacks freedom of movement.	16.1 Turn ball screw and check for freedom of movement. Replace the ball screw if it does not move.

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
16.0 (Continued).	16.2 Chassis voltage may be out of spec.	16.2 Check chassis to ground voltage. Troubleshoot as necessary.
	16.3 Defective motor.	16.3 Check motor for proper voltage and resistance.
	16.4 Defective EPROM or microprocessor.	16.4 Check EPROM and microprocessor for proper signals.
	16.5 Too much resistance in drive train.	16.5 Troubleshoot as necessary.
	16.6 Limit switch wires broken.	16.6 Check limit switches. Replace if broken. Check voltages at switching.
	16.7 P2 cable connected backwards.	16.7 Reconnect cable.
	16.8 Logic board out of spec.	16.8 Check motor pulse U8 Pin 6. Check motor circuits on both digital and power boards.
	16.9 Power board out of spec.	16.9 Check CR25, 22 (F35950) or CR19, 20 (35903) with an oscilloscope for pullup voltages of 20V. Replace diodes if the pullup voltages are less.
	16.10 Regulators of FETS shorted to heat sink.	16.10 Check for shorting. Check for proper isolation between ground plane and components. Replace insulating gaskets as necessary.
17.0 Unit shows erratic behavior.	17.1 Defective Limit switches.	17.1 Check that the limit switches are normally closed. If not, check wires, crimps, and soldering connections, or repair as necessary.
	17.2 Defective opto-switch assembly.	17.2 Check opto-switch output. Output low must be below 0.8 VDC. Output high must be above 3.4 VDC. Replace if voltages are otherwise.

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
17.0 (Continued).	17.3 Broken wires in zero board circuitry associated with outer/inner limit switch or encoder.	17.3 Repair as necessary.
18.0 Unit sounds all alarms except low pressure alarm.	18.1 Alarm battery voltage may be low.	18.1 Check alarm battery voltage for a minimum of 3.6V. Repair circuit if the reading is less.
	18.2 Transducer voltages may be low, (35903).	18.2 Check the transducer voltages. Pin 1 is 0.79 to 0.92 at null.
	18.3 R21 (35903) or R36 (35950) is defective, or a wire is broken in the associated circuitry.	18.3 Replace the resistor or repair wire.
19.0 Chirping sound coming from the alarm.	19.1 Short in motor winding.	19.1 Replace motor.
	19.2 Inadequate isolation in gasket under Q7, (35903).	19.2 Replace gasket. Check for burrs on the heat sink. Resistance must be infinite.
	19.3 Internal breakdown in Q16, (35903).	19.3 Replace Q16.
	19.4 C14 is defective.	19.4 Replace C14.
	19.5 Alarm is defective.	19.5 Replace alarm. Check for oscillating frequency.
	19.6 C7 is leaking, (35903).	19.6 Replace C7.
20.0 No high pressure alarm.	20.1 Berg jumper in wrong position.	20.1 Check that the J1 Berg jumper is removed. Check Q4 and P2 for proper voltage during the alarm mode. Troubleshoot as necessary.
	20.2 Z2 shorted pulling every thing to ground.	20.2 Replace Z2.
21.0 No power loss alarm.	21.1 Wiring on SW1B.	21.1 Check purple and blue wire for proper wiring.
22.0 No power-on alarm.	22.1 Broken wires at power switch.	22.1 Check power switch and associated circuitry.

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
23.0 No alarms.	23.1 U7 on digital board is defective.	23.1 Check U7 and U8 for proper signals.
	23.2 Q7 has shorted causing a constant alarm silence, (F35950).	23.2 Check Q7. Replace if shorted.
24.0 Constant alarm sounds when the unit is on.	24.1 Alarm battery has a low charge.	24.1 Replace alarm battery.
	24.2 No alarm battery.	24.2 Check unit for alarm battery. Install battery if none is present.
	24.3 U8 is defective.	24.3 Check U8, Pin 10 on the digital board.
	24.4 D3 on the zero board has shorted or is breaking down under load.	24.4 Replace D3.
	24.5 Q1, Q2, Q16 has shorted or is breaking down under load, (35903).	24.5 Replace as necessary.
	24.6 Q7 or Q8 has shorted or is breaking down under load, (F35950).	24.6 Replace as necessary.
	24.7 No 5-volt digital.	24.7 Check U2 circuitry, (F35950). Q9, Q10 (35903). Replace as necessary.
25.0 Unit has a rapid beeping alarm and no LCD displays.	25.1 EPROM missing or defective.	25.1 Check unit for EPROM. Replace as necessary.
	25.2 Crystal oscillator not working, (U1, 2, 5, 6, 15, 16, 21, 22, 25, 56).	25.2 Check Pin 8 for proper frequency.
	25.3 14543 driver chip has shorted.	25.3 Inspect IC. Replace as necessary.
26.0 LCD displays flicker during initial turn on.	26.1 U11 is defective.	26.1 Check U11 on the digital board. Check associated circuitry. Repair as necessary.
27.0 LCDs flash when unit is first turned on.	27.1 U7 is defective.	27.1 Check U7 on the digital board. Check associated circuitry. Repair as necessary.

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
Piston Operation Problems		
28.0 Piston hits limit switch intermittently.	28.1 Zero board is defective.	28.1 Troubleshoot as necessary.
	28.2 Limit switches are defective.	28.2 Check for opening and closing of switch. Replace as necessary.
	28.3 Open or shorted wires.	28.3 Check bulkhead harness assembly.
29.0 Piston stalling.	29.1 U3 is defective. Hex buffers for motor out. Motor shorts out when heated.	29.1 Inspect U3. Replace if defective.
	29.2 U6 is defective.	29.2 Inspect U6. Replace if defective.
	29.3 Q14 has shorted.	29.3 Inspect Q14. Replace if shorted. Check FETs in motor circuit. Ensure proper isolation from heatsink.
	29.4 Zero board is defective.	29.4 Troubleshoot as necessary.
	29.5 Mechanical problem with ball screw.	29.5 Replace as necessary.
	29.6 Tightness in piston/ cylinder.	29.6 Adjust as necessary. Replace as required.
30.0 Piston overdrive to bulk-head or left end panel.	30.1 Defective outer limit switch.	30.1 Check that the outer limit switch is open. Replace if it is closed.
	30.2 Inner limit switch is defective.	30.2 Check that the push-button switch is open, with contact. Replace if it is closed.
	30.3 Opto-switch has failed.	30.3 Check the opto-switch output. Output low must be below 0.8 VDC. Output high must be above 3.4 VDC. Replace if otherwise.
31.0 A slight alarm sounds when the piston delivers a breath.	31.1 Internal batteries are low.	31.1 Perform internal battery test. Replace as necessary.
	31.2 Q1 is leaking.	31.2 Inspect Q1, replace if leaking.
	31.3 Ball screw is defective.	31.3 Replace as necessary.

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
31.0 (Continued).	31.4 Piston/cylinder is too tight.	31.4 Adjust as necessary.
	31.5 AC voltage is too low.	31.5 Possible Toroid assembly. Troubleshoot as necessary.
	31.6 Alarm battery does not hold a charge.	31.6 Replace alarm battery.
	31.7 D1 on zero board is leaking.	31.7 Replace D1.
	31.8 Internal battery does not hold charge. Low voltage alarm.	31.8 Allow unit to take a breath over 60 cm pressure. Check TP1 voltage on each breath to make sure it holds charge. Replace batteries if a charge isn't being held.
DUMP VALVE PROBLEMS		
32.0 Dump valve dumps with every alarm.	32.1 Purple and gray cable from zero board are interchanged.	32.1 Check cable. Switch wires if interchanged.
33.0 No dump occurring.	33.1 FET on zero board is blown.	33.1 Replace FET.
	33.2 Pressure switch is mechanically or electrically disconnected.	33.2 Replace as necessary.
	33.3 Dump valve wire is broken.	33.3 If the wire is four inches or more, recrimp. If the wire is less than four inches from contact to dump valve, replace the dump valve.
	33.4 Internal contamination in valve.	33.4 Replace the valve.
	33.5 Vent assembly malfunctioning.	33.5 Troubleshoot as necessary.
34.0 Short alarm occurs with dump.	34.1 Pressure switch is defective.	34.1 Replace pressure switch.
	34.2 Power board.	34.2 Check dump circuitry and alarm circuitry associated with the dump.
	34.3 Zero board FET Q4, Cap C2, Diode D2 or D3.	34.3 Replace as necessary.

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
35.0 No alarm when dump valve is activated.	35.1 CR18 is shorted, (F35950).	35.1 Inspect CR18. Replace if shorted.
36.0 Dump valve functioning intermittently	36.1 Poor dump valve connector. 36.2 Defective or loose pressure switch. 36.3 Vent assembly malfunctioning.	36.1 Inspect dump valve connector. Replace as necessary. 36.2 Inspect pressure switch. Repair or replace as necessary. 36.3 Troubleshoot as necessary.
37.0 Unit is giving a double dump. (The unit begins the breath with a dump; and again before the breath is complete, the gauge needle falls almost to 0 cm pressure then starts to climb again and triggers another dump). High volume, low rate, or low flow may cause a double dump, but this is normal.	37.1 Dump transistor Q4 is defective. 37.2 Check C2 and R8 (digital board). 37.3 Dump valve internally shorting.	37.1 Inspect Q4 on zero board. Replace as necessary. 37.2 Replace as necessary. 37.3 Replace the dump valve.
NOTE: Use the following test to identify an electrical vs. mechanical high pressure limit dump problem. Remove the pressure switch and blow on the high side of the switch, or short the contacts with a screw driver. There is not a problem with the zero board if the dump continues to remain open, (approximately 1.5 seconds), and the alarm sounds for the duration of that time. Replace the dump valve and try again. The dump valve does not work if the vent assembly or pressure switch are not working properly.		
38.0 U1 (35903) or U13 (F35950) constantly blows out.	38.1 Zero reference solenoid is defective. 38.2 Blue and green wires not connected properly. 38.3 Diode on the zero reference solenoid not properly installed.	38.1 Replace the zero reference solenoid and U1 or U13. 38.2 Check that the connector lines up with the blue wires aligned and the green wires aligned. 38.3 Check the zero reference solenoid for proper installation. Replace diode, do not reuse.
39.0 Unit runs from inner limit to midpoint, then stalls.	39.1 Motor winding has a short. 39.2 Problem in motor drive circuit.	39.1 Replace motor. 39.2 Troubleshoot as necessary.

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
40.0 Unit is resetting intermittently.	40.1 U24 digital board LS123 is defective.	40.1 Replace U24. Check for logic low and logic high.
	40.2 Frequency drift on clock oscillator is too great.	40.2 Check for proper frequency coming from U31. Check U30 and U28 if U31 checks out.
41.0 Low pressure alarm set not consistent with settings.	41.1 RP2, RP3, and power switch wires are shorted.	41.1 Check for shorting causing R-pack to fail.
	41.2 Bad pot R2.	41.2 Replace R2, (flow port).
42.0 Low pressure LED fails to extinguish when manometer reaches low pressure.	42.1 Pinched hose.	42.1 Check unit for pinched hoses.
43.0 Spontaneous LED fails to trigger when sensitivity knob is set fully counterclockwise and 10 cm pressure, or greater, is applied.	43.1 RP3 is defective.	43.1 Check RP3 for proper resistance.
	43.2 Power switch wires are shorted.	43.2 Replace wires.
	43.3 Pot sensitivity is defective.	43.3 Replace as necessary.
	43.4 A to D converter is defective.	43.4 Replace as necessary.
44.0 Unit does not initialize when 3 cm pressure is applied to the PAP line and the unit is turned on.	44.1 Harness is defective.	44.1 Replace or repair as necessary.
	44.2 Zero reference solenoid is defective.	44.2 Replace solenoid.
	44.3 Associated wiring and tubing is defective.	44.3 Replace as necessary.
	44.4 Sensor vent blocked.	44.4 Unblock or replace sensor vent.
	44.5 Associated wiring or tubing to solenoid is bad or reversed.	44.5 Repair or replace as necessary.
45.0 Volume delivery not accurate and/or patient outlet is noisy.	45.1 Leaf in patient outlet needs replacing.	45.1 Inspect leaf in patient outlet. Replace as necessary.
	45.2 Opto-switch is intermittently failing.	45.2 Check for proper opto-switch signals.
	45.3 V trim/P trim needs adjusting.	45.3 Recalibrate the unit.

RESPIRONICS®

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE	ACTION / SOLUTION
46.0 Patient outlet is noisy.	46.1 Patient outlet leaf and/or baffle needs replacing.	46.1 Check for noise during air movement. Replace the leaf valve if flapping occurs. Check that the baffle is properly sealed.
47.0 No external charging voltage at TP4.	47.1 U15 is shorted (F35950) Q8 (35903).	47.1 Replace U15 and Q8 if shorted or no voltage is present. Check input for proper voltage.
48.0 No internal battery charging at TP1.	48.1 U10 is shorted and blown CR21 (F35950) causing the circuit to open. Q6, CR2 (35903).	48.1 Inspect U10, CR21 or Q6, CR2. Replace as necessary.
49.0 Unit does not switch to the external battery.	49.1 K1 is defective causing the power relay solenoid to short; no voltage at contact solder pads.	49.1 Inspect K1. Replace as necessary. Check for fractured solder joints. Check DC receptacle.
50.0 Cannot trigger a breath in assist control mode.	50.1 Pressure transducer on AMP board (35904) or power board (F35950) is shorted.	50.1 Inspect transducer, and replace as necessary.
51.0 Alarm capacitor does not hold a charge.	51.1 Capacitor is defective.	51.1 Replace capacitor.
52.0 Unit does not calibrate when P trim (R4) is adjusted.	52.1 Piston ring, leaf checks, or bulkhead gasket is leaking	52.1 Inspect and repair as necessary.
	52.2 Bulkhead nuts are not tightened.	52.2 Torque nuts to 20" pounds.
	52.3 Volume needs to be recalibrated.	52.3 Check volumes on RT-200A.
53.0 No voltage at any test points.	53.1 Fusable trace on power board has blown.	53.2 Repair as necessary.

Operational Checks

Section 5.0

Operational Checks
Diagnostic Check
Unit Start-up and AC/DC Operation
Power Board Voltages
Chassis to Ground Test
Low Voltage Alarm Test
Alarm Battery Charging and Alarm Battery Test (power board 35903)
Alarm Capacitor Test (power board F35950)
Leakage Current Check
Ground Resistance Test
Tidal Volume Display Range
Rate: Patient BPM Display Range
Inspiratory Flow Rate Display Range
I:E Ratio Display Range
Piston/Cylinder Operation
Measure Volume Delivery
Outer Limit Switch Operation
Zero Reference Solenoid, Pressure Gauge Check
Cylinder Leakage Check
Dump Valve
Pressure Relief Valve Operation
SIMV Mode Operation
Assist Control Mode Operation
Inspect Power Switch
Visual Inspection
Inspect for ECOs

Operational Checks

▼Operational Checks are used to find any discrepancies that may exist with the operation of the unit. If a unit fails any of these checks, other than a discrepancy requiring minor repairs, the steps in Sections 6.0 through 10.0 MUST be performed.

Diagnostic Check

▼Plug the unit into an AC power supply. Turn on the PLV-100. A five second sequence of automatic, internal, diagnostic checks automatically occurs. This checks the front panel digital displays, the LEDs, the audible alarm, the pressure transducer, the zero reference solenoid, the associated circuits, and the EPROM checksum for proper operation. When performing this check, verify the following:

All digital displays (LCDs) read 8s for one second. This confirms the integrity of each digital display (the I:E RATIO display reads 1:8.8 for one second, and then display a fixed number 1: that is always on).

Each front panel LED illuminates in the following sequence:

1. INCREASE INSPIRATORY FLOW
2. ASS'T/SPONTANEOUS
3. 15 SEC. DELAY
4. EXTERNAL BATTERY Power Source
5. INTERNAL BATTERY Power Source
6. VAC Power Source

The TIDAL VOLUME digital display then reads 0.0. This confirms the integrity of the pressure transducer, the zero reference solenoid, the associated circuits, and the EPROM checksum. Failure of the pressure transducer, the zero reference solenoid, or the associated circuits, causes the TIDAL VOLUME display to read 1.0 and the alarm sounds. If failure of the EPROM checksum occurs, the TIDAL VOLUME display reads 2.0.

The audible alarm then sounds to indicate the end of the diagnostic check and confirm that all systems are operable and the unit is functioning normally.

Unit Start-up and AC/DC Operation

Tools
12-volt Adjustable DC Power Supply

▼ When connected to an AC power source, unit start-up and operation must be normal. During normal operation the green power source VAC LED is illuminated.

NOTE: On International 100/220/240 VAC units the green power source VAC LED must be illuminated when the unit is plugged into a 100/220/240 VAC power source **with the unit turned OFF**. When the unit is unplugged from a 100/220/240 VAC power source, the green power source VAC LED must stay illuminated between 5 and 15 seconds.

Unit Start-up and AC/DC Operation
Continued

On all 120 VAC units the green power source VAC LED **must not light** when the unit is plugged into a 120 VAC power source with the power off.

If the green power source VAC LED is not functioning properly flip the SW-3 switch located on the logic board. This switch indicates a U.S. position or an International position. Check that there is a plastic cap covering the SW-3 switch.

Perform the following to check for proper AC/DC operation:

Pull out the VAC circuit breaker. Within six seconds, the power source LED indicates the INTERNAL BATTERY as the power source, and the alarm sounds for three seconds (3-second alarm).

Connect an external 12-volt power source to the EXTERNAL BATTERY 12 VDC outlet on the faceplate module. The power source LED indicates the EXTERNAL BATTERY as the power source, and the 3-second alarm sounds.

Pull out the VDC circuit breaker. The constant power failure alarm sounds.

Push in the circuit breakers to reset, and disconnect the external 12-volt power source.

Power Board Voltages

Tools
Voltmeter (98577)

▼There are two styles of power boards. The earlier version power board (35903) is identified by eight test points along the top edge of the board, (this board is no longer available for order). The later version power board (F35950) is identified by twelve test points along the top edge of the board. Refer to Table No. 1 for voltage specifications for each of the test points.

Remove the top panel of the unit to check the voltages on the power board.

Using a voltmeter, connect the black lead to ground (TP2) and the red lead to each test point, one at a time, to check specifications.

Operational Checks

Power Board Voltages

Continued

TEST POINT	VOLTAGE NAME	UNIT	SPEC.	ADJUST
TP1	Internal Charging	off/fuse out	13.90 - 14.30 VDC	R51
TP2	Ground	plugged in	none	none
TP3	Raw	off/plugged in	18.0 - 26.0 VDC	none
TP4	External Charging	off	13.90 - 14.30 VDC	R37
TP5	Line Voltage	on	13.45 - 14.95 VDC	none
TP6	Alarm Capacitor	off	4.50 VDC minimum	none
TP7	+5 Volt Analog	on	4.90 - 5.10 VDC	none
TP8	+5 Volt Digital	on	4.80 - 5.20 VDC	none
TP9	+5 Volt Transducer	on	4.95 - 5.05 VDC	none
TP10	PX 10 Voltage	on	2.65 - 2.80 VDC	none
TP11	PX 1 Voltage	on	2.80 - 2.95 VDC at 25 cm	R22
			1.30 - 1.40 VDC at 0 cm	R23
TP12	Dump Circuit	on	0.80 - 1.0 VDC at 0 cm	R2
			2.50 - 2.70 VDC at 95 cm	R1
Anode of CR10	15-volt Regulator	on	14.25 - 15.75 VDC	none

Table 1: *Later Version Power Board (F35950)*

Chassis to Ground Test

Tools
Voltmeter (98577)

▼Turn on the unit. Connect the leads from a multimeter to the power board using a 1 Meg ohm shunt. Connect the black lead (negative) to ground (TP2) and the red lead (positive) to the chassis. The multimeter reading must not exceed 1.0 VDC. Turn off the unit, remove the shunt and disconnect the unit from the AC power source. Change the meter to the highest ohms scale (200 KW), the meter must read infinite.

Low Voltage Alarm Test

Tools
Voltmeter (98577)
12-volt Adjustable DC Power Supply

▼Set the operating parameters as follows:

Unit = ON
MODE = Control
TIDAL VOLUME = 1.00 Liters
RATE: PATIENT BPM = 2 BPM
INSPIRATORY FLOW = 45 LPM

Connect a 0-12 volt adjustable DC power supply to the EXTERNAL BATTERY 12 VAC outlet on the faceplate module. Connect the black lead, from a voltmeter, to ground (TP2), and the red lead to line voltage (TP5).

Low Voltage Alarm Test
Continued

Turn on the unit. Slowly reduce the power supply voltage. The unit starts sounding an alarm at approximately 9.5 VDC, as indicated by the voltmeter. The alarm increases in volume as the volume continues to decrease.

NOTE: Line voltage is pulled down during piston movement. **Measure the battery voltage when the piston is stationary.**

If the unit is not alarming at 9.5 VDC, adjust the alarm pot by turning, R21 on the earlier version power board (35903), or R36 on the later version power board (F35950), clockwise until the unit sounds the alarm at 9.5 VDC. Disconnect the 0-12V adjustable DC Power Supply.

Alarm Capacitor Test (power board F35950)

▼Turn on the unit. Pull out the VDC circuit breaker causing the alarm to sound. At the same time, start a stopwatch. The alarm must sound for a minimum of five minutes.

Leakage Current Check

Tools
SI-100 Leakage Tester

▼With the leakage tester turned off, connect the AC plug to the leakage receptacle on the SI-100 leakage tester. Turn on the tester. Readings in "forward" and "reverse" must not exceed 100 micro amps.

Ground Resistance Test

Tools
SI-100 Leakage Tester

▼With the SI-100 leakage tester turned off, connect the AC plug to the resistance receptacle on the tester. Turn on the tester. Probe all metal areas on the outside of the ventilator. The highest reading must not exceed 0.1 ohm.

Tidal Volume Display Range

▼Turn the TIDAL VOLUME knob on the ventilator completely counterclockwise. The unit must display 0.05 liters. Turn the knob completely clockwise. The unit must display 2.99 liters.

Rate: Patient BPM Display Range

▼Set the TIDAL VOLUME at 0.40 liters (0.30 liters when testing a 30 BPM PLV-100). Turn the RATE: PATIENT BPM knob completely counterclockwise, and then completely clockwise. The unit must display the range from 2 to 40 BPM ± 2 BPM (from 2 to 30 BPM ± 2 BPM when testing a 30 BPM PLV-100).

Inspiratory Flow Rate Display Range

▼Turn the INSPIRATORY FLOW knob completely counterclockwise, and then completely clockwise. The unit must display the range from 10 to 120 LPM.

Operational Checks

I:E Ratio Display Range

▼By adjusting the TIDAL VOLUME, RATE: PATIENT BPM, and INSPIRATORY FLOW, check that the I:E RATIO displays a range from 1:0.3 to 1:9.9 LPM.

Piston/Cylinder Operation

▼Check that the unit is operating smoothly with no abnormal or excessive noise or chatter.

Measure Volume Delivery

Tools
RT-200A or equivalent measuring device
PEEP Valve

▼Set the TIDAL VOLUME to 0.05 liters, the RATE:PATIENT BPM to 10 BPM, and the INSPIRATORY FLOW to 10 LPM. Connect the hose circuit to the faceplate module of the unit and to a RT-200A, or equivalent measuring device. Remove the PEEP and exhalation valves from the test circuit. Measure the total of ten breaths, and divide the total breaths by 10. The volume must be between 0.03 and 0.07 liters. Adjust the P-trim (R4) on the digital board clockwise to increase the volume or counterclockwise to decrease the volume.

Set the TIDAL VOLUME to 2.70 liters, the RATE:PATIENT BPM to 10 BPM, and the INSPIRATORY FLOW to 120 LPM. Reconnect the exhalation valve to the hose. Measure one breath. The volume must be between 2.43 and 2.97 liters. Adjust the V-trim, R18 on the digital board clockwise to increase the volume, or counterclockwise to decrease the volume. Repeat both the low and high volume delivery checks as necessary to obtain the specified volume delivery.

NOTE: Turn off the unit and then back on after adjusting the V-Trim or P-Trim. This allows the microprocessor to "read" the P-Trim and V-Trim values.

Outer Limit Switch Operation

Tools
Test Circuit

▼Attach the test circuit to the patient air outlet. Disconnect the zero board, (located at the base of the bulkhead assembly), cable as identified by the green, yellow, and orange wires. The piston travels past zero and contacts the bulkhead push-button switch, causing the alarm to sound. Reconnect the zero board.

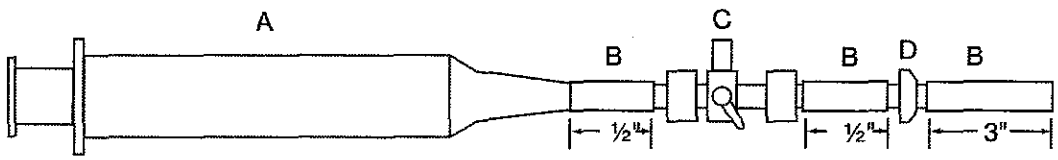
Set the Tidal Volume knob clockwise to 2.80 liters. The piston must not actuate the outer limit switch, and an alarm must not sound. Slowly increase the volume. Do not run the turcite nut off the ballscrew. The outer limit switch actuates between 2.81 and 2.95 liters. To prevent damage to the switch do not allow the piston to hit the switch with any force.

Adjust the switch, by bending the leaf, to activate between 2.81 and 2.95 liters. There must be no bowing of the left module before the switch activates. Turn the unit off.

Zero Reference Solenoid, Pressure Gauge Check

Tools
Test Syringe
Pressure Gauge

▼Disconnect the tubing from the front module pressure gauge and connect it to the "tee" on Magnehelic pressure gauge tube. Connect the end of the tube from the Magnehelic pressure gauge to the front module pressure gauge. Attach a test syringe, (see figure 5-1), to the PAP outlet. A RT-200A or equivalent measuring device may also be used to measure pressures.



A	Syringe 60 CC	98148	C	Valve Stop Cock	98553
B	3/16 Inch Tube	C06686	D	Valve Check	98554

Figure 5-1: *Test Syringe*

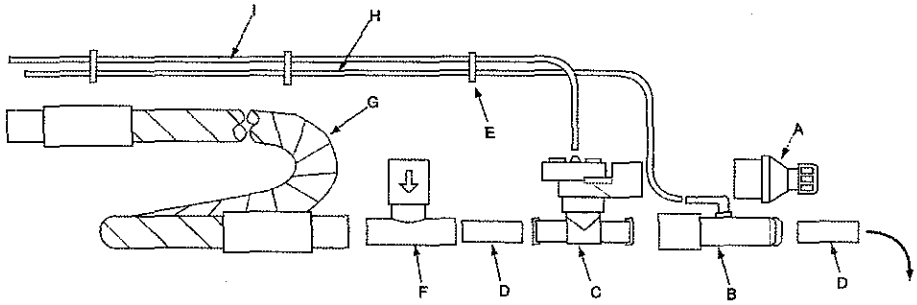
Apply 40 cm of pressure to the PAP assembly using a syringe tool. The reading on the unit pressure gauge must be within 10% of the Magnehelic gauge reading. The pressure in the PAP assembly must not drop more than 6 cm of pressure in 30 seconds. If the pressure does drop more than 6 cm, check the "tee" assembly, the gauge straight connector, or the PAP outlet for leakage.

With at least 5 cm pressure still applied to the PAP line, turn on the unit. The unit runs through its diagnostic check and begins breath delivery. If the unit keeps running through the diagnostic check and does not start breath delivery the solenoid valve, the pressure transducer or their associated circuits are malfunctioning and may require replacement or repairs.

Cylinder Leakage Check

Tools
Test Circuit
RT-200A
Gate Valve (90902)

▼Set the TIDAL VOLUME to 1.80 liters, the RATE: PATIENT BMP to 10 BPM, and the INSPIRATORY FLOW to 84 LPM (the I:E ratio reads approximately 1:2.0). Connect an RT-200A, (or equivalent), and gate valve (90902) to the patient air outlet via a test circuit. Check that the gate valve is fully open, (the pressure on PLV-100 gauge must read less than 10 cm). Allow a few breaths for unit to stabilize, then measure the volume of five breaths.



A	Peep Valve	C06712	F	SIMV Manifold Adapter	C06247
B	PAP Adapter	C06232	G	24" Clear Hose	C06526
C	Exhalation Valve	C06706	H	Assist/PAP Line	C06686
D	Coupler	C06348	I	Exhalation Valve Line	C06685
E	Hose Clip	C06793			

Figure 5-2: *Test Circuit*

Operational Checks

Cylinder Leakage Check
Continued

Gradually close the gate valve until the pressure measured on the PLV-100 manometer gauge peaks at 40 cm. Measure the volume of five breaths at 40 cm pressure. Subtract the reading at 40 cm from the reading with no pressure. The difference must be less than 0.35 liters, (0.07 per breath).

If the difference is greater, check for leaks around the piston, ball screw, bulkhead, motor, etc. Tighten or replace these parts if necessary, and then retest.

Dump Valve

Tools
RT-200A (or equivalent)
Test Circuit

▼Connect an RT-200A, (or equivalent measuring device), in series with the unit pressure gauge. Set the TIDAL VOLUME to 0.50 liters, the RATE: PATIENT BPM to 10 BPM, and the INSPIRATORY FLOW to 10 LPM.

Connect a test circuit with a 1 liter test lung to the patient outlet of the unit.

Turn the airway pressure limit knob fully counterclockwise. The dump valve must operate between 0 and 10 cm pressure. Turn the vent knob fully clockwise. The dump valve must operate between 85 and 105 cm.

Refer to Section 10.0, for complete instructions on proper dump valve calibration.

Pressure Relief Valve Operation

Tools
Test Circuit
Test Lung (C06658)
Pressure Gauge

▼Adjust the pressure relief valve if it does not release pressure between 105 cm and 115 cm. Exercise the valve at least one time before reading the pop-off pressure.

Connect a test circuit with a test lung and a Magnehelic gauge (or equivalent gauge capable of reading in excess of 120 cm H_2O) to the PLV-100.

Note: Remove and occlude tubing to front panel pressure guage, otherwise it may become damaged.

Unplug the dump valve solenoid from P4 on the power board or use a berg jumper on J1(35950 only). Turn the pressure vent shaft completely clockwise. Turn on the unit, and adjust the operating parameters as follows:

MODE = Control
TIDAL VOLUME = 1.5
RATE: PATIENT BPM = 4 BPM
INSPIRATORY FLOW = 10 to 40 LPM

For units with an earlier version power board (35903), place a finger over the small hole in the vent body, on the side opposite of the pressure switch. This prevents a small air leak. Listen for the pressure relief valve to release the pressure between 105 cm and 115 cm.

If the valve does not release the pressure, turn the nut located on the inside of valve clockwise to increase the pressure using a ¼-inch nut driver. To decrease the pressure, turn the nut counterclockwise. Do not turn the nut in either direction more than 360°.

Pressure Relief Valve Operation
Continued

Continue to adjust and retest until the pressure relief valve releases pressure between 105 cm and 115 cm. Replace the valve if it still does not release pressure in the proper range.

After successful testing of the pressure relief valve, reconnect the dump valve solenoid plug to the power board or remove the berg jumper and reconnect the pressure gauge.

Assist Control Mode Operation

Tools
Test Circuit
Test Lung (C06658)
Pressure Gauge

▼Turn the mode switch to Assist Control. Turn the sensitivity knob completely clockwise causing the unit to auto cycle. The Assist/Spontaneous LED illuminates after every stroke and breath rate increases.

Slowly close the PEEP valve on the test circuit until the unit stops auto cycling.

Slowly open the PEEP valve. The low pressure alarm LED illuminates between 2 and 4 cm H_2O pressure. Fully open the PEEP valve.

Gradually reduce sensitivity until the unit stops auto cycling. Remove the test lung and gently breath in on the PAP line. The Assist/Spontaneous LED illuminates at a maximum of -0.50 cm pressure.

Turn the sensitivity knob completely counterclockwise. Gently breath in on the PAP line. The Assist/Spontaneous LED illuminates at a minimum of -6.0 cm H_2O.

Reduce the BPM to 5. Turn the sensitivity knob to approximately the 2 o'clock position. The unit must not auto cycle. Gently breath in on the PAP line every five seconds. After five breaths the rate reads between 11 and 13 BPM.

SIMV Mode Operation

Tools
Test Circuit
Test Lung (C06658)
Pressure Gauge

▼Set the mode switch to SIMV. The I:E RATIO displays 1:. Place a Magnehelic gauge in series with the unit pressure gauge. Gently breath in on the PAP line every five seconds. After five breaths the rate reads between 11 and 13 BPM.

Adjust the rate to 2 BPM and the low pressure knob to 20 cm H_2O pressure. Connect a test lung to the circuit as the machine takes a breath. The unit alarms within 20 seconds.

Remove the test circuit tubing from the PAP outlet and attach a syringe. Place between 18 and 22 cm H_2O pressure on the unit gauge. The unit stops alarming and the low pressure LED turns off within this range. Remove the syringe and reinstall the test circuit tubing. Adjust the low pressure knob to 2 cm H_2O pressure and adjust the operating parameters to 0.50 liters, 2 BPM, and 10 LPM. Turn off the unit and remove the Magnehelic gauge. Turn the mode switch to control and the sensitivity knob completely clockwise.

Operational Checks

Inspect Power Switch

▼Remove the power switch from the faceplate module. Check that the back side of the switch is solid. All switches that do not have solid backs must be replaced with solid back switches. All units which do not have the protective covers over the power switch must have the power switch replaced with one that has the protective cover installed. Reference ECO #2088 to perform power switch replacements.

Visual Inspection

▼Visually inspect the external surfaces of the PLV-100 for scratches or cracks in the case. Replace the top, bottom, and side panels as necessary.

Inspect for ECOs

▼Verify that all mandatory ECOs are installed. If an ECO is missing, the unit automatically fails operational checks. For a listing of ECOs refer to Section 8.0.

Preventive Service

Section 6.0

Preventive Service Guidelines
Preventive Service Procedures
Motor Change Requirements
ECOs

Preventive Service

Preventive Service Guidelines

▼The following preventive service procedures are followed each time a PLV-100 is serviced. Preventive Service is performed once per year or every 8,000 hours according to the hour meter.

NOTE: The following Preventive Service procedures MUST be followed each time a PLV-100 ventilator is serviced unless the number of hours remaining since the last preventive service is greater than 6,500 hours and the unit is not being service due to a consumer complaint.

Preventive Service Procedures

▼Section 7.0 provides detailed information on performing these preventive procedures.

- Replace or clean the PATIENT AIR INLET and MACHINE AIR VENT filters found on the back panel.
- Replace the Krytox lubricant (35408) in the ball screw/silent block assembly.
- Replace the seal spring (35465).
- Clean the baffle and replace the check valve leaf(s) (33440) in the patient intake port on the bulkhead, and in the patient outlet.

NOTE: For earlier versions of the PLV-100, the bulkhead must be removed prior to replacing the check valve leaf in the patient intake port. Refer to Relocating the Inlet Check Valve Leaf (Section 7.0) for more information.

- Clean or replace all interior pneumatic tubing, as necessary.
- Replace internal batteries (35277), as necessary.
- Replace damaged items of a cosmetic nature, as necessary.
- Check the O-rings under the knobs on the faceplate module for rotting, replace as necessary.
- Replace the motor (F35062) at 30,000 hours ± 2,000 hours.

Refer to motor change requirements for more detailed information.

NOTE: The motor is not included in the cost of Preventive Service for customer owned equipment.

- Check the power board voltages, and adjust as necessary.
- Test the low voltage alarm, and adjust as necessary.
- Check the relief valve, and adjust as necessary.
- Check the dump valve, and adjust as necessary.
- Check the TIDAL VOLUME, and adjust as necessary.
- Perform the chassis to ground test.
- Perform the ground leakage test.
- Replace any items damaged due to abuse or misuse such as; impact, liquid spills, battery acid spills, etc., as necessary.

Preventive Service Procedures
Continued

Motor Change Requirements

▼The original motors (35036), with a black and silver label and a copper-layered armature were installed in the PLV-100 from 1984 through 1988. Their maximum useful service life was determined to be 10,000 units as recorded on the PLV power meter.

In August 1988, an improved motor (F35062) with a black and yellow label and a nickel-plated armature became available. This motor, is being used in all PLVs today. It provides an expected average service life of up to a maximum of 30,000 hours. As with all electromechanical devices, the expected service life is an average figure, not an absolute number. Since 1988, the label used on these motors has been various different colors. Any motor that does not have a black and silver label is the most current improved motor.

In June 1988, PLV-100s changed from using **power meters**, to show accumulated motor power usage, to actual time **hour meters**. Hour meters were installed in all units manufactured after July 1988, and are retro-fitted into earlier units using ECO #2073 in Section 8.0 of this Service Procedure as a routine engineering update.

MOTOR WARRANTY AND CHANGE-OUT: the following is a brief summary of the current Respironics® motor warranty and Preventive Service change-out policy.

The original copper-layered armature motors (35036) with the black and silver labels should be changed out by this time, as they have exceeded their maximum 10,000 power meter reading.

The copper-layered armature motor change applies to all PLV ventilators with serial numbers beginning with 84, 85, 86, 87, and 88, that have a motor with a black and silver label.

Motor Change Requirements
Continued

The current motor (F35062), with the nickel plated armature and any colored label besides black and silver must be changed by 30,000 hours, as indicated on the **hour meter**. The hour meter must not be confused with the originally installed **power meters** which recorded only accumulated power units applied to the motor during use.

The Respironics® warranty on any new PLV ventilator, including its motor or other components, is one year regardless of the number of hours on the motor or the hour meter.

Service Representatives must carefully screen all units submitted for service and:

A) Ensure that any Respironics® rental unit has had the proper motor replacement, especially any unit found to still contain the original copper-layered armature motor with the black and silver label.

B) Strongly recommend to the client or user that the appropriate motor change be made according to the guidelines in this procedure.

C) If the owner of a unit refuses to have the motor changed, refer to Company Bulletin #921037 (Domestic USA), or #921036 (International) for the proper procedure on how to document a client/owner refusal to have the ventilator motor changed. The information and procedures in these Company Bulletins must be followed, and the proper refusal letters must be signed by the client/owner and then filed in the Device History Record for that ventilator.

ECOs

▼Install all applicable ECOs, including those listed below. Refer to Section 8.0, Engineering Change Orders, for detailed installation instructions.

Mandatory Engineering Change Orders (ECOs)

ECO#1156	18 Segment to 128 Segment Encoder
ECO#2073	Hour Meter Installation
ECO#2088	Installation of Capacitor Auxiliary Board, Power Switch Change, and Cover Installation
ECO#2730	Watchdog Timer Resistor Change to 127K ohm
ECO#2876	Multiplexer U19 Change (National chips only)
ECO#2992	Krytox Lubrication Change
ECO#3288	Reset Pulse Circuit C7 Capacitor Change
ECO#3814	Power Board 35950 C26 Capacitor Change
ECO#3909	Digital Board Counter/Timer (U28) Change
FC2001-46	Alarm Assembly Upgrade

NOTE: For optional engineering updates, refer to Section 11.0.

Disassembly, Inspection and Reassembly

Section 7.0

Disassembly, Inspection, and Reassembly
Remove the Top, Bottom, and Side Panels
Lower the Left Module
Replacing the Toroid Assembly
Lower the Right Module
Lower the Faceplate Module
Removal of the Digital Board
Remove the Vent Assembly (power board 35903)
Calibrate Airway Pressure Limit (vent assembly and power board 35903)
Electronic Dump Service (power board F35950)
Calibrate Airway Pressure Limit (electronic dump and power board F35950)
Remove Patient Outlet Assembly (version 1)
Remove Patient Outlet Assembly (version 2)
Remove Back Module
Remove Amp Board (power board 35903)
Reassemble Amp Board (power board 35903)
Removal of the Motor Assembly
Relocating the Check Leaf Valve
Motor Lead Resistance Test (optional)
Mounting PLV-100 Optical Switch Assembly
Silent Block/Ball Screw Assembly
Ball Screw Assembly Inspection
Bulkhead, Cylinder and Piston Service
Ball Screw Assembly Lubrication
35903 Power Board Retrofit
Alarm Replacement
Alarm Block Assembly Change Out
Unit Final Assembly